PIER Energy-Related Environmental Research
Environmental Impacts of Energy Generation, Distribution and Use

Physical Modeling of CO_2 Sequestration

Contract #: 500-02-004-WA MR-043-09
Contractor: Stanford University
Contract Amount: $74,793
Contractor Project Manager: Roland N. Horne
Commission Project Manager: Gina Barkalow
Commission Contract Manager: Beth Chambers

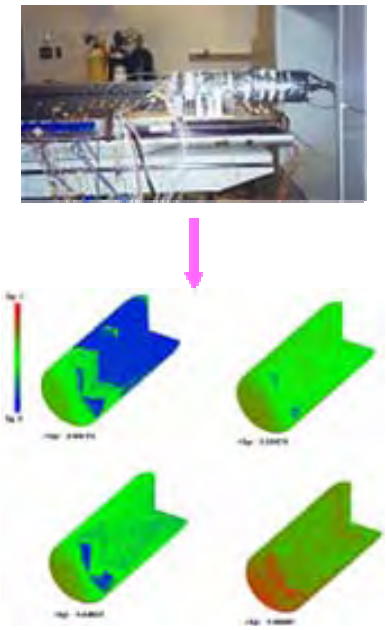
The Issue

Disposal of carbon dioxide (CO_2) from power plants burning natural gas, crude oil, and coal is a key strategy for reducing the atmospheric carbon levels responsible for global warming. One possible disposal method is to sequester CO_2 into deep reservoirs and aquifers.

The relative permeability of water/CO_2 flow in such reservoirs would play an important role in CO_2 injection and sequestration, as well as in the evaluation of CO_2 leakage from geologic disposal reservoirs. Engineering risks would be reduced if reliable relative permeability estimates could be obtained.

Another important factor influencing the performance of CO_2 injection and sequestration is CO_2 interaction with the water that exists in reservoirs. The solubility of CO_2 in water influences the effectiveness of CO_2 storage in reservoirs. However, fundamental understanding of the interaction between two-phase flow mechanisms and solubility mechanisms is still poor.

This project will provide a clearer understanding of the chemistry involved in CO_2 sequestration and thus enable a more certain estimate of its feasibility.



Using an X-ray scanner, the displacement of gas (red) into water (blue) can be visualized and measured. This will allow the measurement of CO_2/water relative permeability.

Project Description

This project will physically model the fluid flow of water/CO_2 systems, using a modification of a device developed earlier by Stanford's geothermal research group to study steam-water flow. Pressure, temperature, and flow rates during water/CO_2 two-phase flow will be recorded by a

data acquisition system. Once these data are available, relative permeability and other fluid flow properties can be calculated. Liquid saturation and its distribution will be monitored using an X-ray CT scanner. Finally, the water/CO_2 two-phase relative permeability curves as well as the features of the distribution of fluid saturation will be obtained. The main tasks are as follows:

- Modify and construct the experimental apparatus to model fluid flow and to measure relative permeability in water/CO_2 systems
- Conduct the physical simulation of two-phase water/CO_2 flow in a porous medium
- Measure relative permeability in water/CO_2 systems using an X-ray CT scanner
- Conduct theoretical studies and understand the mechanisms of water/CO_2 two-phase flow
- Develop mathematical models of water/CO_2 two-phase relative permeability for application to reservoir engineering

The principal technical contribution of this project will be the measurement of fluid flow in water/CO_2 two-phase systems. This information will be useful to engineers, scientists, and state agencies in planning future strategies for CO_2 injection and sequestration.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objective:

- **Resolving the environmental effects of energy production and use.** CO_2 sequestration into deep reservoirs and aquifers is a promising approach to reducing greenhouse gases in the atmosphere. Sequestration technology would enable the continued use of fossil energy with less impact on environment. This research will reduce the uncertainty in engineering evaluations, thereby lowering the risks and associated costs of CO_2 sequestration.

Final Report

PIER-EA staff intend to post the final report on the Energy Commission website in fall 2007 and will list the website link here.

Contact

Gina Barkalow • 916-654-4057 • gbarkalo@energy.state.ca.us